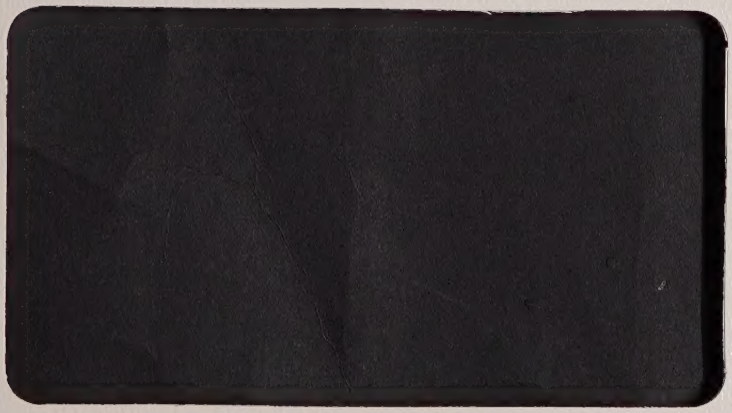
GenRad

Tek Dallas



Instruction Manual

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GR 1311-A
Audio Oscillator

Form 1311-0100-00

©GenRad, Inc., 1988

Concord, Massachusetts, U.S.A. 01742
December, 1988

SPECIFICATIONS

FREQUENCY

Range: 1311-A, 50 Hz to 10 kHz. Eleven fixed frequencies, 50, 60, 100, 120, 200, 400, and 500 Hz, 1, 2, 5, and 10 kHz. One other frequency can be added at an unused switch position, a Δf control provides ±2% continuous adjustment.

Accuracy: ±1% of setting with Δf control at zero.

Stability (typical at 1 kHz): Warmup drift, 0.3%. After warmup: 0.008% short term (10 min), 0.02% long term (12 h).

Synchronization: Frequency can be locked to external signal. Lock range ±3% per volt rms up to 10 V. The Δf control functions as phase adjustment.

OUTPUT

Voltage: Continuously adjustable from 0 to 1, 3, 10, 30, or 100 V open circuit (E_{oc}).

Power: >1.0 W into matched load, >0.5 W into any resistive load between 80 mΩ and 8 kΩ.

Current: Continuously adjustable from 0 to 40, 130, 400, 1300, or 4000 mA, into approx short circuit (I_{sc}).

Impedance: One to three times $\frac{E_{oc}}{I_{sc}}$, depending on output amplitude. Output isolated from ground.

Distortion: <0.5% with any linear load. Oscillator will drive a short circuit without clipping.

Hum: <0.01%, independent of output setting.

Synchronization: Constant-amplitude (1-V), high-impedance (4.7-kΩ) output to drive counter or oscilloscope.

GENERAL

Power Required: 105 to 125 or 210 to 250 V, 50 to 400 Hz, 30 W.

Terminals: Output, GR 938 Binding Posts and ground terminal with shorting link; sync, side-panel telephone jack.

Accessories Supplied: Power cord, spare fuses.

Accessories Available: Adaptor cable 1560-P95 (telephone plug to double plug), rack-adaptor set.

Mounting: Convertible-bench cabinet.

Dimensions (width x height x depth): 8 x 6 x 7¾ in. (205 x 155 x 200 mm).

Weight: Net, 6 lb (2.8 kg); shipping, 9 lb (4.1 kg).

Catalog Number	Description
	1311-A Audio Oscillator
1311-9701	for 115-V
1311-9702	for 230-V
1560-9695	**1560-P95 Adaptor Cable**
0480-9838	**480-P308 Rack-Adaptor Set**

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WARRANTY

We warrant that this product is free from defects in material and workmanship and, when properly used, will perform in accordance with applicable GenRad specifications. If within one year after original shipment it is found not to meet this standard, it will be repaired or, at the option of GenRad, replaced at no charge when returned to a GenRad service facility. Changes in the product not approved by GenRad shall void this warranty. GenRad shall not be liable for any indirect, special, or consequential damages, even if notice has been given of the possibility of such damages.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

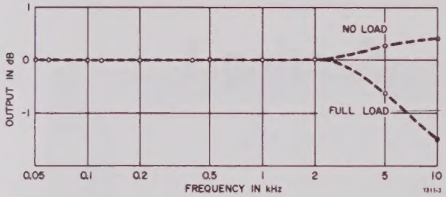
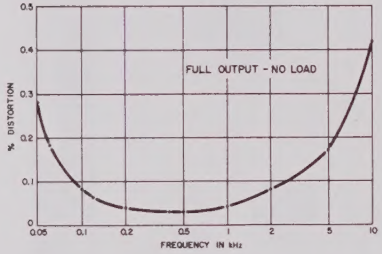
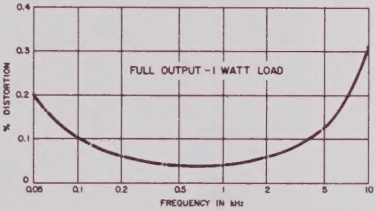


Figure A. Output of Type 1311 as a function of frequency, loaded and unloaded (typical).





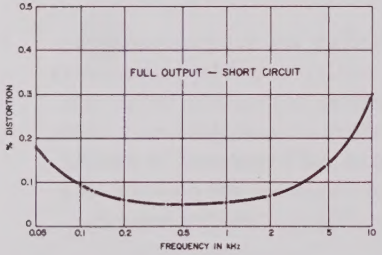


Figure B. Distortion characteristics of Type 1311 as functions of frequency and load (typical).

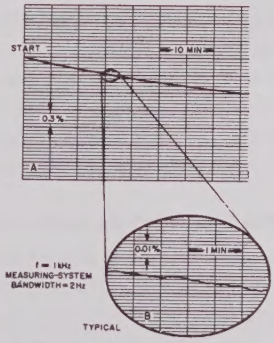


Figure C. Typical output amplitude stability of the oscillator, showing warmup drift (A) and short-term variation (B).

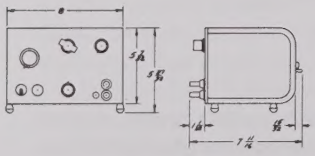


Figure D. Dimensions of the Type 1311.

Introduction–Section 1

1.1 PURPOSE.

1.1.1 General.

The Type 1311 oscillators are complete, compact, and self-contained audio-frequency sources. The Type 1311-A (Figure 1-1) is intended for general laboratory use, and is particularly well suited for use in audio-frequency bridge measurements. Each oscillator produces an essentially pure sinusoidal output, stable in amplitude and frequency, over a wide range of load impedances, at selected frequencies. The Type 1311-A has eleven fixed frequencies and provision for a twelfth, which the user can readily add by installing two precision resistors.

1.1.2 The Type 1311 As Audiometric Oscillator.

The Type 1311 is capable of being used for calibration and testing of audiometric equipment. It will be especially useful for calibration of audiometric earphones, in conjunction with the Types 1933 and 1565 Sound Level Meters, (or the Type 1564 Sound and Vibration Analyzer), the Type 1560-P5 or -P6 (or the Type 1560-P3 or -P4) Piezoelectric Ceramic Microphone, and the Type 1560-P82 (or -P81) Earphone Coupler. The frequencies available from the Type 1311 include most of those commonly used as audiometric test frequencies. Refer to para. 5.8.2 for details on adding a 12th frequency.

1.2 DESCRIPTION.

1.2.1 General.

The Type 1311 is a transistorized RC Oscillator, which makes extensive use of negative feedback to attain amplitude and frequency stability of a high order,

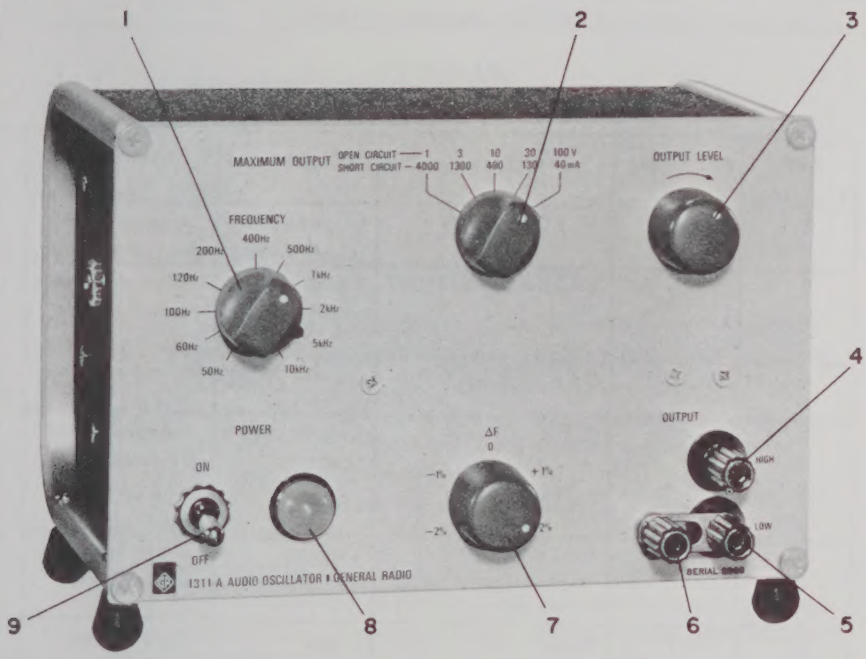


Figure 1-1. Type 1311-A Audio Oscillator.

as well as long-term reliability. The output system uses a multitap shielded transformer capable of matching impedances from 0.25 to 2500 ohms. It is well isolated from the oscillator circuitry to provide a distortion-free waveform to any impedance, including a short circuit.

The instrument is ac powered and uses a regulated solid-state power-supply circuit to provide stable dc to all stages over a wide range of power demands. Operation at ac inputs of 115 or 230 volts can be achieved by selection of appropriate taps on the input winding of the primary power transformer.

The Type 1311 is designed for bench use but can conveniently and inexpensively be altered for rack mounting by the addition of the General Radio Type 480-P308 Adaptor Plate Set (Catalog No. 0480-9838).

1.2.2 Controls.

Front panel controls are listed and described in Table 1-1.

TABLE 1-1
CONTROLS AND INDICATORS

Ref (Fig. 1-1)	Ref Desig	Name	Type	Function
1	S101	FREQUENCY	12-position rotary switch	Selects output frequency.
2	S102	MAXIMUM OUTPUT	5-position rotary switch	Selects output transformer tap.
3	R139	OUTPUT LEVEL	Linear potentiometer	Adjusts output level.
7	R138	Δ F	Linear potentiometer	Adjusts output frequency ±2% about nominal.
9	S501	POWER	Toggle switch	Turns instrument on or off.
8	P501	None	Light	Glows when primary power on.

1.2.3 Connectors.

Connectors provided on the Type 1311 are listed and described in Table 1-2.

TABLE 1-2
CONNECTORS

Ref (Fig. 1-1)	Ref Desig	Name	Type	Function
4-6	J101 thru J103	OUTPUT	Jack-top binding posts (GR Type 938)	Output terminals and ground.
	PL501	None	3-prong plug	Power input terminal.
	J104	None	Telephone	External Sync input

Installation–Section 2

2.1 GENERAL.

The Type 1311-A Audio Oscillator, as supplied, is intended for independent bench use. However, it may be adapted to rack mounting, either independently or in combination with a similarly sized instrument, such as the General Radio Type 1232-A, -AP Tuned Amplifier and Null Detector. This assembly, Type 1240-A, -AP Bridge Oscillator-Detector is convenient for use with audio-frequency bridges and other null-balance devices.

2.2 RACK MOUNTING.

2.2.1 Rack Converting The Type 1311.

The Type 1311 Oscillator can be rack-mounted by itself in a standard 19-inch relay rack by means of Relay Rack Adaptor Set, Catalog Number 0480-9838, or with another convertible-bench instrument by means of Relay Rack Adaptor Set, Catalog Number 0480-9836. To attach the adaptor sets, proceed as follows (see Figure 2-1):

a. Remove the rubber feet, if necessary to clear an instrument below.

b. Remove the screws that secure the front panel to the aluminum end frames.

c. Remove the spacers between the front panel and the end frames. If two instruments are to be mounted side by side, join them as follows: (otherwise proceed to step f):

d. On one instrument, install clips with the front-panel screws removed earlier. Remove the cover of this instrument and thread the nylon screw through the hole in the side panel on the same side as the clips.

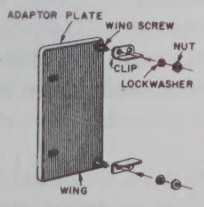


Figure 2-1a. Rack adapting the Type 1311.

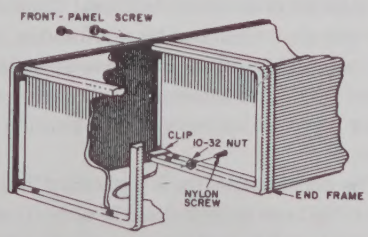


Figure 2-1b. The Type 1240.

e. Secure the two instruments together with front-panel screws through the remaining hole in each clip. Remove the cover of the second instrument, thread the nut onto the nylon screw, and tighten. Note that the instruments can be bench-mounted side by side in this manner. Simply do not remove the two feet from each outside end frame and do not install the adaptor plates.

f. Install two clips on each adaptor plate with the wing screws, lockwashers, and nuts supplied.

g. Attach the adaptor plates to the instrument with the front-panel screws removed earlier.

h. Mount the assembly in the rack with the 10-32 screws supplied.

2.2.2 Mounting The Type 1620-A, -AP.

The Type 1311 oscillator is an integral part of the Type 1620-A, -AP Capacitance-Measuring Assembly. To assemble a Type 1620-AP, a Type 1232 Detector, Type 1232-P2 Preamplifier, Type 1615 Bridge, Type 4177-1621 System Cabinet and Type 1620-A, a Type 1232 Detector, Type 1615 Bridge, Type 4177-1620 System Cabinet and Type 1620-A hardware set are needed. Proceed as follows:

a. Follow steps a through e in paragraph 2.2.1 for a 1620-A installation, or steps a through I of the Type 1240-AP assembly procedure in the Type 1232-P2 Instruction Manual, for a 1620-AP installation.

b. Insert the "ears" of the mounting plates included in the Type 1620-A or -AP hardware set in the spaces between the front panels and the end frames of the Type 1311 and Type 1232.

c. Replace all remaining front panel screws.

d. Mount the Type 1615 in the lower part of the system cabinet using eight panel screws with natural Nylon cup washers.

e. Mount the 1311-1232 combination in the upper portion of the cabinet using four panel screws with Nylon cup washers.

2.3 POWER INPUT.

2.3.1 Normal Operation.

The instrument is fitted with a power-connector that is in conformance with the International Electrotechnical Commission publication 320. The 3 flat contacts are surrounded by a cylindrical plastic shroud that eliminates the possibility of electrical shock whenever the power cord is being unplugged from the instrument. In addition, the center ground pin is longer, which means that it mates first and disconnects last, ensuring greater user protection from electric shock.

The panel connector is a standard 3-pin grounding -type, the design of which has been accepted world wide for electronic instrumentation, and is rated for 250 V at 6A. It also meets requirements of Underwriter's Laboratories in the

U.S. and the Canadian Standards Association. The receptacle accepts power cords fitted with the Belden type SPH-386 connector.

The associated power cord is GR part no. 4200-9625. It is a 7-ft, 3-wire, 18-gauge unit with connector bodies molded integrally with the jacket. The connector at the power-line end is a stackable hammerhead design that conforms to the "Standard for Grounding Type Attachment Plug Caps and Receptacles," ANSI C73.11-1963.

The power cord supplied should be attached to PL501 on the rear panel and plugged into a standard grounding-type power receptacle providing 105-125 volts at 50 to 400 Hz.

2.3.2 Higher Voltage.

The instrument may be operated at ac inputs from 210 to 250 volts, provided that minor wiring and fuse changes described in Section 5 have been performed.

2.4 OUTPUT FREQUENCY CHANGE.

To add a 12th audio output frequency (Type 1311 only), or to change any of the existing fixed frequencies, resistor pairs in the Wein-bridge circuit may be installed, or replaced, as described in Section 5.

2.5 ENVIRONMENTAL CONSIDERATIONS.

2.5.1 Temperature.

The Type 1311 will operate within specifications over an ambient temperature range of 0 to 50 C. It is not affected by humidity.

2.5.2 External Fields.

Since the Type 1311 is often mounted with the sensitive Type 1232-A Null Detector, stray magnetic and electrostatic fields should be kept to a minimum by suitable shielding, and orientation of signal leads. A wire loop is included (internally) near the output terminals to cancel the magnetic field resulting from the ¾-inch spacing of the output terminals, and will prevent magnetic pickup in the adjacent null detector, even at high current levels, if a General Radio Type 274-MB Shielded Output Cable is used. Alternatively, the Type 1311 can be mounted at the right-hand side of the Type 1232-A, to place the output circuit as far as possible from the detector input terminals.

Operating Procedure—Section 3

3.1 PREPARATION FOR USE.

3.1.1 Power Connections.

Connect the Type 1311 to a suitable source of power as indicated on the plate above the power receptacle on the rear panel.

3.1.2 Grounding.

The instrument should normally be operated with the chassis grounded through the three-wire power cord. If the cord is not used, make the ground connection at J103 (6, Figure 1-1) on the front panel, if required.

3.1.3 Output Connection.

Take the oscillator output from the jack-top binding post pair J101 — J102 (4 and 5, Figure 1-1). J101 is always used above ground, but J102 may be grounded or ungrounded, depending on the requirements of the test setup in use. A captive shorting-link affixed to J103 may be attached to J102, if it is desired to work one side of the output against ground. However, if ground loops pose a problem, disconnect the shorting link from J102 to achieve a completely isolated "floating" output.

3.1.4 Output-Shielding Accessories.

In applications in which stray pickup is apt to be troublesome, use of a shielded patch cord is suggested. The General Radio Type 274-NL Patch Cord, a polarized 3-foot shielded cable with a shielded double plug at each end, is available for this purpose.

3.2 OPERATING PROCEDURE.

3.2.1 Turn-On.

Place the POWER switch (9, Figure 1-1) in up position; the lamp immediately to the right should glow.

NOTE

No extensive warm-up time is required; a few seconds is sufficient.

3.2.2 Frequency Selection.

Set the FREQUENCY switch (1, Figure 1-1) to the desired frequency. Use the ΔF control (7, Figure 1-1) to adjust the selected frequency over a range of approximately ±2% of nominal. The frequency of the output waveform is within ±1% of the panel engraving, with the ΔF control set at 0. For greater precision monitor the output with a counter, such as the General Radio Type 1191 counter.

3.2.3 Power Selection.

Set the MAXIMUM OUTPUT switch (2, Figure 1-1) to a value in volts or milliamperes (as screened on the front panel) that is slightly greater than the amplitude of the voltage or current desired. Then, rotate the OUTPUT control (3, Figure 1-1) to make the fine adjustment. The OUTPUT control sets the output at zero in its fully counterclockwise position, and rotated to its fully clockwise position provides a continuous linear increase up to the value of the MAXIMUM OUTPUT control setting.

The maximum power output is approximately 1.1 watt, so that bridges with 1-watt ratio arms, such as most General Radio bridges, can not be damaged by overload. At least 0.58 watt of signal power can be supplied to any load between 80 milliohms and 8 kilohms, with the appropriate setting of the output switch. See Figure 3-1 for a plot of these values.

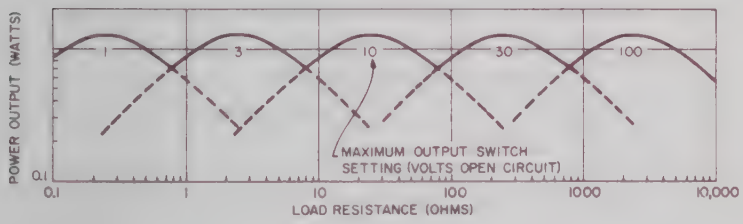


Figure 3-1. Typical power output as a function of load resistance.

3.2.4 Impedance Matching.

Any setting of the output controls can be used with any load impedance without overloading the oscillator circuits. Even with a short circuit across the output terminals, the oscillator will still supply a sinusoidal current of the value indicated by the MAXIMUM OUTPUT control. This feature is particularly convenient when the oscillator is used as a source for ac bridge measurements, since it means that the output controls can be set to any position, and the waveform will not be distorted by mismatching.

The output winding is shielded from the oscillator circuits and may be used ungrounded, or grounded at a remote point. The latter procedure is recommended when the oscillator is used in bridge measurements, to eliminate circulating ground currents, which can cause errors.

The nominal source resistance is a function of the transformer tap selected by the MAXIMUM OUTPUT control setting and the position of the OUTPUT control. Figure 3-2 shows the relationship.

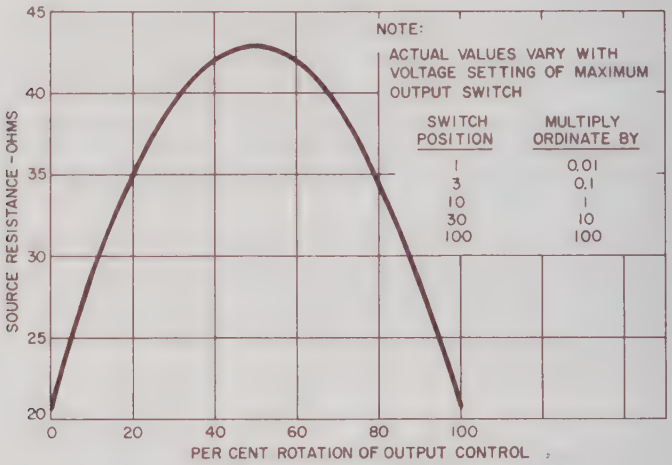


Figure 3-2. Source resistance as a function of output control settings.

3.2.5 Frequency Synchronization.

A telephone jack (J104) on the left side wall of the cabinet is provided to permit injection of an external standard frequency to control the output frequency of the Type 1311. This is particularly useful to drive the Type 1615-A Capacitance Bridge when making precise measurements of frequency-sensitive parameters such as dissipation factor. A 1-volt signal will result in a locking range of approximately ±3%. For larger synchronizing signals, a resistor should be added in series with the signal lead. Use the following equation to calculate the value of the resistor required.

$$R \text{ (in kilohms)} \approx 5 \text{ (Sync Volts} - 1)$$

The dc voltage on the reference signal should not exceed +50 volts. For additional information on synchronization, write for Instrument Note 109.

The 1-watt amplifier and matching transformer of the 1311-A can be driven by any of the 1300 oscillator series between 50 and 10,000 Hz. Set the 1311-A's FREQUENCY switch to the blank position and plug the external oscillator into the sync jack.

Principles of Operation—Section 4

4.1 GENERAL.

The Type 1311-A Audio Oscillators use a Wien-type network and a closed-loop, transistor-amplifier circuit to obtain a stable yet inexpensive signal source which will satisfy many oscillator requirements in the audio-frequency spectrum. See Figure 4-1 for a simplified diagram and Figure 5-2 for the complete schematic.

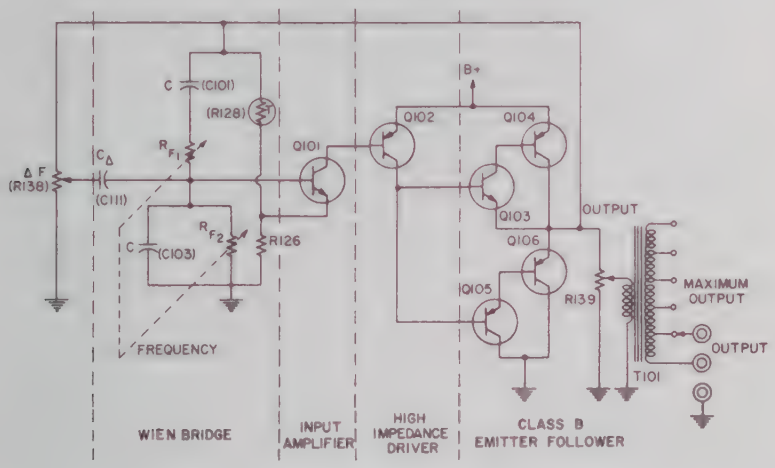


Figure 4-1. Simplified schematic diagram.

4.2 CIRCUIT DESCRIPTION.

4.2.1 Frequency-Determining Network.

The Wien-bridge circuit can be thought of as consisting of two parts: a frequency-determining network (C101, C103 and paired resistors R_{F1}.R_{F2}), which provides positive feedback to sustain oscillation, and a resistive divider (R128 and R126) which provides negative feedback to stabilize amplitude.

The frequency-determining network has a transfer function:

$$\frac{e_{OUT}}{e_{IN}} = \frac{RCs}{1 + 3RCs + R^2C^2s^2}$$

where $s = j2\pi f$

$R = R_{F1} = R_{F2}$

$C = C101 = C103$

At some oscillator frequency, f_o, this function equals +1/3. The frequency is determined by any of 11 pairs of precision metal-film resistors, R_{F1}, R_{F2}, selected by the FREQUENCY switch. With this circuit, frequency can be adjusted over a 200-to-1 range simply by changes in resistors. The frequency vernier adjustment, ΔF, is potentiometer R138, which controls the signal voltage on CΔ (C111), one of the capacitors in the network.

The resistive divider is used to set the gain of the associated amplifier chain to +3. The net loop gain is then +1 and the circuit oscillates at the frequency f_o.

A small bead thermistor, R128, automatically adjusts its resistance to the value needed to maintain oscillations. Its time constant is short enough to provide rapid correction for amplitude variations, yet long enough to cause little distortion at the lower frequencies. It operates at a high temperature, in an evacuated bulb, to minimize the effects of ambient temperature. This thermistor, used with the high-stability, low-noise amplifier described below, results in an oscillator with amplitude (modulation) noise typically less than 0.01% rms.

4.2.2 Amplifier.

The amplifier uses six transistors in a single, direct-coupled feedback loop. The input circuit is chosen for low-noise performance. Transistor Q102 provides a high-impedance drive for the class-B output stage, and achieves a minimum of crossover distortion, yet does not require complicated, temperature-sensitive biasing networks. Negative feedback is used to obtain a transfer characteristic which is substantially independent of transistor characteristics, resulting in excellent stability, low distortion, and long-term reliability. Components R132, C107, and C108 comprise a phase-compensation network used to maintain high-frequency stability in view of the large amount of negative feedback involved.

The input impedance of the amplifier is approximately 10 megohms. The output impedance is approximately 0.005 ohm, so that changes in load have very little effect on the oscillator.

4.2.3 Output Transformer.

The winding resistance of the output transformer, T101, isolates the oscillator from the load and ensures that the output waveform will not be clipped under any load condition. The output winding is tapped to provide five switch-selectable, output-voltage ranges to match a wide variety of load requirements.

The output winding is doubly shielded from the oscillator circuits for isolation, when the output is used off ground (floating). A simplified schematic diagram of the output circuit is shown in Figure 4-2.

The second shield is used to minimize possible current flow through the distributed capacitance, C_{FL} (≈500pf), thence through an external circuit ground. The resulting floating potential, E_{FL}, of the output winding is less than 0.25 volt.

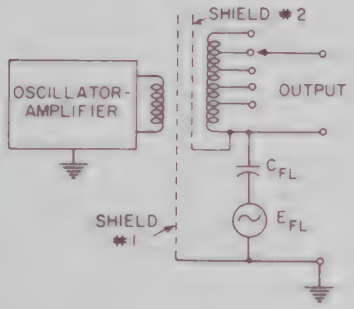


Figure 4-2. Simplified schematic diagram of output circuit.

4.2.4 Power Supply.

Power transformer, T501, is used to apply 25.5 v ac to a silicon-diode bridge-rectifier and filter circuit. The filtered dc output passes through a simple regulator circuit, made up of Q501, Q502, and CR505, a zener diode. The supply provides a low-impedance, ripple-free, 20-v dc source to power the oscillator circuitry. The hum level of the oscillator output is typically 90 db below rated output signal value.

Service and Maintenance—Section 5

WARNING

Dangerous voltages are present inside the case of this instrument. For safety, do not remove instrument from its case. Refer all servicing to qualified personnel.

5.1 GR FIELD SERVICE.

Our warranty (at the front of this manual) attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone the nearest GR service facility (see back page), giving full information of the trouble and of steps taken to remedy it. Describe the instrument by type, serial, and ID numbers. (Refer to front and rear panels.)

5.2 INSTRUMENT RETURN.

Before returning an instrument to General Radio for service, please ask our nearest office for a "Returned Material" number. Use of this number in correspondence and on a tag tied to the instrument will ensure proper handling and identification. After the initial warranty period, please avoid unnecessary delay by indicating how payment will be made, i.e., send a purchase-order number or (for transportation charges) request "C.O.D."

For return shipment, please use packaging that is adequate to protect the instrument from damage, i.e., equivalent to the original packaging. Advice may be obtained from any GR office.

5.3 MINIMUM PERFORMANCE STANDARDS.

The Type 1311 in normal operation should perform within the standards described in Table 5-1. Table 5-2 lists the test equipment required to check minimum performance. If the instrument does not meet minimum performance standards, refer to paragraph 5.6 for trouble analysis procedures.

5.4 INPUT POWER.

The input power at 115/230 volts 60 Hz normally should not exceed 7 watts no load and 30 watts with the terminals short-circuited and the OUTPUT control fully clockwise.

TABLE 5-1
MINIMUM PERFORMANCE STANDARDS FOR TYPE 1311-A

TEST	FREQUENCY SWITCH POSITION	MAXIMUM OUTPUT SWITCH POSITION	OUTPUT CONTROL POSITION	ΔF POSITION	LOAD	NORMAL INDICATION	IF INDICATION ABNORMAL
Frequency Accuracy	All	10 v	cw stop	0	None	Using frequency counter or meter, check that the frequency is within ±1% of nominal value.	Refer to para 5.6.
Δf Control	1 kHz	10 v	cw stop	-2%, 0, +2%	None	Using frequency counter or meter, check that frequency change is approximately plus and minus 2%.	Refer to para 5.6.
Output Voltage	1 kHz	10 v	cw stop	0	None	Using VTVM, check that output voltage is greater than that indicated by MAXIMUM OUTPUT Control.	Adjust by means of R129 (para 5.8.1).
Output Voltage	All	10 v	cw stop	0	None	Using VTVM, check that output voltage is greater than 10 volts.	Adjust by means of R129 (para 5.8.1).
OUTPUT Control	1 kHz	All		0	None	Using VTVM, check that output voltage can be adjusted by OUTPUT Control	Refer to para 5.6.
Output Power	1 kHz	10 v	cw stop	0	Power Output Meter	Using Power Output Meter, check that output power is greater than 1.0 watt into some impedance near 25 Ω.	Adjust by means of R129 (para 5.8.1).
Output Distortion	50 Hz 1 kHz 10 kHz	10 v	cw stop	0	(None) (25 Ω) (1 Ω)	Using Distortion Meter, check that distortion is less than 0.5%.	Refer to para 5.6.
Synchronization	1 kHz	10 v	cw stop	0	None	Apply 1-v, 1-kHz signal to J104. With oscilloscope at OUTPUT, vary ext.-oscillator freq. Type 1311 should remain locked over a6% range (approx)	Refer to para 5.6.

TABLE 5-2
TEST EQUIPMENT REQUIRED

Description	Recommended GR Type Numbers*
Frequency Counter	1191
Vacuum Tube Voltmeter	1806-A
Distortion and Noise Meter or Wave Analyzer	1932-A, or 1900-A
Output-Power Meter	1840-A
Variable-Frequency Audio Oscillator	1310
Oscilloscope	Laboratory quality, min bandwidth 1 kHz, min vert sensitivity 5 v/cm
Multimeter	Sensitivity 20,000 ohms/v

*Or equivalent

5.5 REMOVAL OF COVER.

To remove the cover, loosen the two captive thumb screws on the rear of the case and pull straight back.

5.6 TROUBLE ANALYSIS.

Perform the following procedures to isolate defects causing instrument malfunction as indicated by paragraphs 5.3 and 5.4. See Figures 5-1 through 5-5 for circuit function and part location.

a. Disconnect primary power and remove cover.

b. Check fuse F502; replace if defective.

c. Visually check detail parts inside instrument for obvious defects, such as broken leads or charred surfaces. Repair or replace, as necessary.

d. Reapply primary power and, with multimeter, check for 25 v ac across anchor terminals AT501 and AT502.

CAUTION

Semiconductor elements can be damaged by transients resulting from the insertion of instrument probes. Always turn off the power before connecting any test equipment to other than the output terminals. Restore power when connection is made.

e. Switch multimeter to dc scale and check voltages as indicated on Figure 5-2. For accessibility of test points on etched-circuit board, see Figure 5-5.

NOTE

Complete circuit is enclosed in a single dc feedback loop, so that failure of one component will probably cause all voltages to differ considerably from the values shown.

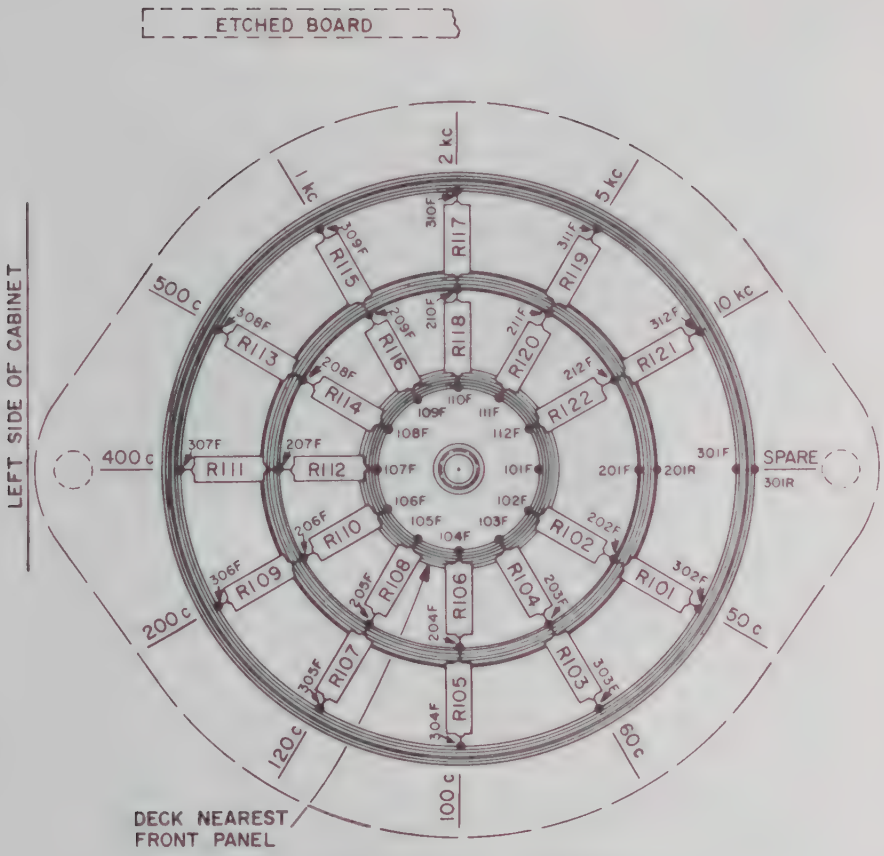


Figure 5-1. Wiring diagram for FREQUENCY switch S101 on the Type 1311-A.

5.7 REMOVAL AND REPLACEMENT.

5.7.1 General.

Faulty parts should be removed and replaced by units meeting the description given in the Parts List at the end of this section.

5.7.2 Semiconductors.

Since the expected life of the semiconductor elements in the Type 1311 is comparable to that of other components, they are soldered into the circuit boards. As a general rule, it is much safer to determine the faulty semiconductors from over-all circuit test, rather than to remove them individually for testing.

CAUTION

Transistors are easily damaged by excessive heat; exercise care when unsoldering them.

5.7.3 Pilot Light.

The pilot light (P501) is operated well below its rated voltage. If a change is required, unscrew the red cap from the front of the panel and replace the light with a Mazda #44.

5.8 INTERNAL ADJUSTMENTS. (See Figures 5-2 through 5-5.)

5.8.1 Oscillator Level.

R129, a secondary control used to adjust oscillator power level, is a screwdriver-adjustable potentiometer mounted on the underside of the etched circuit at its inside edge. With the dust cover removed, it is accessible from the bottom of the instrument.

R129 should be set so that the no-load output voltage, as indicated by a VTVM across the OUTPUT terminals, is approximately 5% higher than the value indicated by the MAXIMUM OUTPUT switch, when the OUTPUT control is turned fully clockwise.

5.8.2 Oscillator Frequency.

Any frequency between 50 hertz and 10 kHz can be added to those provided on the Type 1311-A, by the installation of two precision resistors, R_F, whose values can be determined from the following relation:

$$R_F = 1.61 \times 10^3 \frac{(1\ \text{kHz})}{(f_{\text{kHz}})}$$

To utilize the twelfth position of the FREQUENCY selector switch, first calculate the value of the resistors required. For example, if a 600-Hz output is wanted, then

$$R_F = 1.61 \times 10^3 \frac{(1)}{(0.6)} = 2.68 \text{ kilohms.}$$

The resistors must be mounted on the FREQUENCY switch (S101). An unused position (between the 50-Hz and 10-kHz positions) is provided for this purpose. Before installing the resistors on S101, remove the jumper between contacts 101F and 201F. The contacts 101F, 201F, and 301F may be reached from the bottom of the instrument. See Figure 5-1 for switch details.

5.9 AC POWER CONVERSION.

5.9.1 General.

The Type 1311 is available from the factory wired either for use with inputs of 105 to 125 or 210 to 250, 50 to 400 Hz. However, if the user wishes to convert the instrument from one power option to the other, it is necessary merely to change wiring to the power-transformer input winding from power switch S501 and replace fuses.

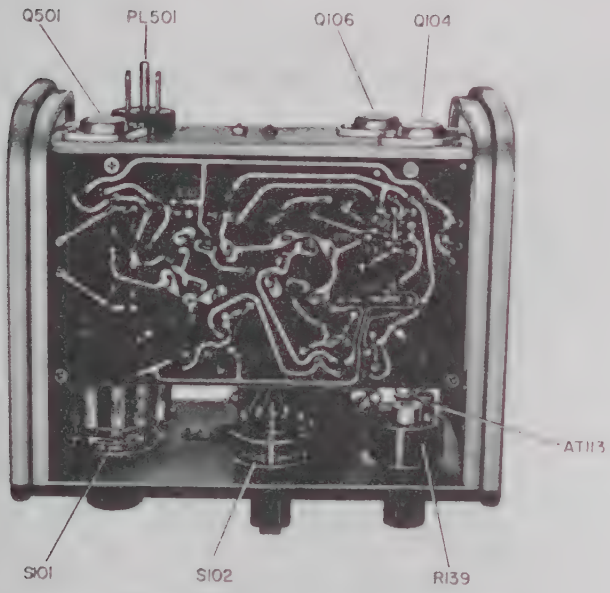


Figure 5-3. Top rear interior view.

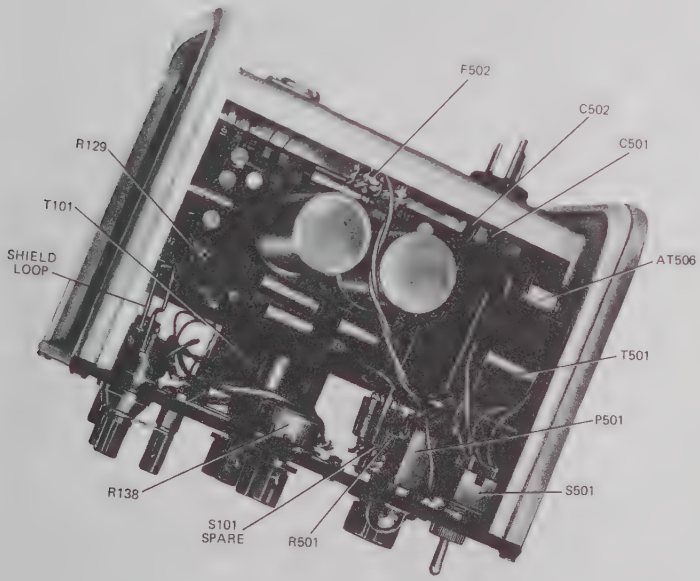


Figure 5-4. Bottom rear interior view.

WARNING

Pull the power cord from the receptacle before performing the following procedures.

5.9.2 Transformer Wiring.

Remove the dust cover and place the instrument upside down on the bench. The input transformer (T501) is mounted on the side wall.

For 115-volt operation, transformer leads 1 and 3 should connect to lug 5 on S501 and leads 2 and 4 to lug 6 on S501. For 230-volt operation, lead 1 connects to lug 5, lead 4 to lug 6, and leads 2 and 3 are joined at anchor terminal AT506.

5.9.3 Fuses.

A fuse, F502, mounted on the inside of the vertical panel at the top rear, protects the instrument from electrical overload. It is accessible from the bottom, also. For 115 v, use 0.3 amp fuses; and for 230 v, use 0.15 amp fuses.

5.10 KNOB REMOVAL AND INSTALLATION.

To remove a knob, proceed as follows:

a. Grasp knob firmly with fingers, close into panel and pull straight away from the panel.

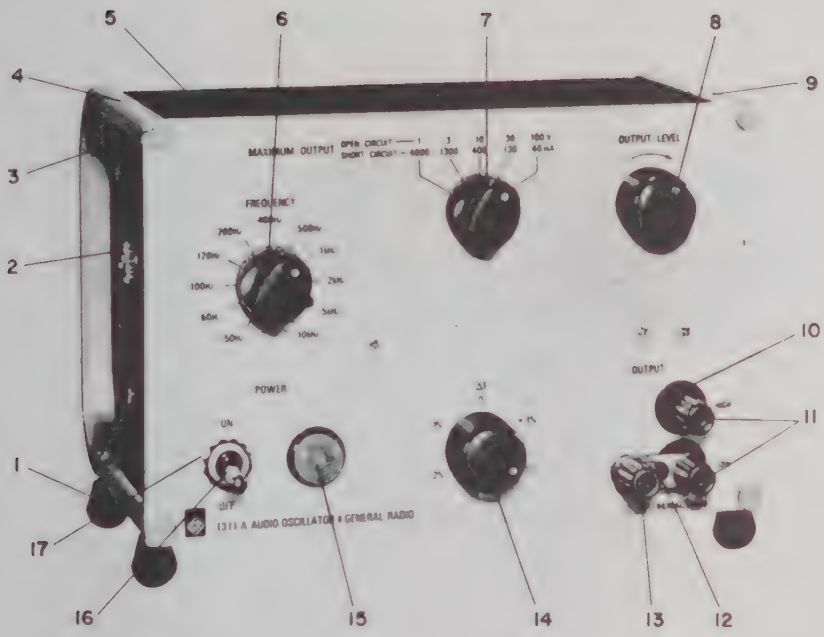
b. Observe position of bushing setscrew with respect to any panel markings, release setscrew and pull bushing off shaft. To install a knob, proceed as follows:

a. Mount bushing using paper as a shim.

b. Orient setscrew to markings noted when it was removed. Tighten setscrew. The shaft must not protrude through bushing.

c. Place knob on bushing with retention spring opposite setscrew.

d. Push knob in until it bottoms and pull it slightly to check spring retention. If knob-retention spring comes loose, reinstall it in interior notch with small slit in outer wall.



MECHANICAL PARTS LIST

Figure Reference	Description	GR Part Number	Fed Mfg. Code	Mfg. Part No.
1	FOOT, rubber, soft, No. 10-32 top, 4 required	5260-0700	24655	5260-0700
2	NUT, dress, 3/8-32	5800-0805	24655	5800-0805
3	SCREW, Phillip-head with washer No. 10-32, 1/2-in., 4 required	7098-0160	24655	7098-0160
	WASHER (between panel and end frame) metal, No. 10, 4 required	8100-1517	24655	8100-1517
4	END FRAME, left	5310-3065	24655	5310-3065
5	DUST COVER Assembly	4429-1500	24655	4429-1500
6, 7	KNOB (includes tension spring), bar, white dot and line	5500-5321	24655	5500-5321
	BUSHING (includes setscrew), metal	4143-3121	24655	4143-3121
	TENSION SPRING	5220-5402	24655	5220-5402
8, 14	KNOB (includes tension spring), skirted, white dot and line	5520-5321	24655	5520-5321
	BUSHING (includes setscrew), metal	4143-3121	24655	4143-3121
	TENSION SPRING	5220-5402	24655	5220-5402
	WASHER, metal, No. 1/4	8100-0400	24655	8100-0400
9	END FRAME, right	5310-3064	24655	5310-3064
10	INSULATOR, gray, 4 required	0938-7130	24655	0938-7130
11	BINDING POST ASM.	0938-3000	24655	0938-3000
12	SHORTING LINK, metal	5080-4800	24655	5080-4800
13	BINDING POST ASM.	0938-3022	24655	0938-3022
15	PILOT LAMP CAP, red	5620-0800	72619	95-935 Cap (Unfluted)
16	SWITCH, toggle, double-pole single-throw	7910-1300	04009	83053-SA
17	NUT, dress, 15/32-32	5800-0800	24655	5800-0800

FEDERAL SUPPLY CODE
FOR MANUFACTURERS
From Defense Logistics Agency Microfiche
H4-2 SB 708-42 GSA-FSS H4-2

Ref FMC Column
in Parts Lists

Code	Manufacturer
00136	McCoy Electrs, Mt Holly Springs, PA 17065
00192	Jones Mfg, Chicago, IL 60181
00194	Walco Electrs, Los Angeles, CA 90018
00321	Welwyn Instrs, Westlake, OH 44145
00434	Schweber Electrs, Wheeling, NY 11590
00656	Aerovox, New Bedford, MA 02745
00779	AMP Inc, Harrisburg, PA 17105
01009	Alden Products, Brockton, MA 02413
01121	Allen Bradley, Milwaukee, WI 53204
01255	Litton Inds, Beverly Hills, CA 90213
01281	TRW Lwondale, CA 90260
01295	TI, Dallas, TX 75222
01526	GE, Waynesboro, VA 22980
01930	Amerock, Rockford, IL 61101
01963	Cherry Electr, Waukegan, IL 60085
02111	Spectrol Electrs, City of Industry, CA 91746
02114	Ferroxcube, Saugerties, NY 12477
02606	Fenwall Lab, Morton Grove, IL 60053
02639	GF, Schenectady, NY 12301
02660	Amphenol, Broadview, IL 60153
02735	RCA, Somerville, NJ 08876
02768	Ferro, Desplaines, IL 60018
03042	Carter Ink, Cambridge, MA 02142
03508	GE, Syracuse, NY 13201
03540	Vanguard Electrs, Inglewood, CA 90302
03636	Greyburne, Yonkers, NY 10701
03877	Transtron Electrs, Wakefield, MA 01880
03888	KDI Pyrofilm, Whippany, NJ 07981
03911	Claires, New York, NY 10001
04009	Arrow Hart, Hartford, CT 06106
04843	Dygricinics, Allendale, NY 11507
04713	Motorola, Phoenix, AZ 85008
04919	Components Mfg, W Bridgewater, MA 02379
05079	Tamastic Electrs, Bennington, VT 05201
05245	Corcom, Chicago, IL 60630
05278	ITT Electrs, Pomona, CA 91766
05400	Controls Co of Amer, Melrose Pk, IL 60160
05574	Viking Inds, Chatsworth, CA 91311
05624	Barber-Colman, Rockford, IL 61101
06148	Barnes Mfg, Mansfield, OH 44901
06220	Wakefield Eng, Wakefield, MA 01880
06383	Pandult Tinley Pk IL 60477
06406	Truetone & Mackay, Waterbury, CT 06708
06666	Precision Monolith, Santa Clara, CA 95050
06743	Clevite, Cleveland, OH 44110
06783	Pyrofilm, Whippany, NJ 07981
07047	Birtcher, N Los Angeles, CA 90032
07595	Amer Semicond, Arlington Hts, IL 60004
07699	Magnetic Corp, Newburgh, NY 12550
07707	USM Fastener, Shelton, CT 06484
07828	Bodine, Bridgeport, CT 06605
07829	Bodine Electr, Chicago, IL 60618
07910	Cent Device, Hauppauge, NY 11787
07983	State Labs, New York, NY 10003
07999	Borg Inst, Delevan, WI 53115
08524	Deutsch Fastener, Los Angeles, CA 90045
08556	Bell Electrs, Chicago, IL 60632
08730	Vemaline Prod, Franklin Lakes, NJ 07417
09213	GE, Buffalo, NY 14212
09353	C&K Components, Watertown, MA 02172
09408	Star-Tronics, Georgetown, MA 01830
09823	Burgess Battery, Freeport, IL 61032
09856	Fenwal Electrs, Framingham, MA 01701
09922	Burndy, Norwalk, CT 06852
10025	Glassed Prod, Lindsay, CA 93247
10389	Chicago Switch, Chicago, IL 60647
11236	CTS of Berne, Berne, IN 46711
11599	Chandler Evans, W Hartford, CT 06101
11983	Nortronics, Minneapolis, MN 55427
12040	National Semi, Santa Clara, CA 95051
12045	Electro Transistors, Fairview, NJ 11354
12498	Teledyne, Mountain View, CA 94043
12617	Hamlin, Lake Mills, WI 53551
12672	RCA, Woodbridge, NJ 07095
12697	Clarostat, Dover, NH 03820
12954	Micrometals, City of Industry, CA 91744
12964	Dickson Electrs, Scottsdale, AZ 85252
12969	Unitrode, Watertown, MA 02172
13004	Electrocraft, Hopkins, MN 55343
13103	Thermalloy, Dallas, TX 75234
13148	Vogue Inst, Richmond Hill, NY 11418
13150	Varnitron, Lacona, NH 03246
13237	Solitron Devices, Tappan, NY 10983
13715	Fairchild, San Rafael, CA 94903
13919	Burr Brown, Tucson, AZ 85706
14010	Anadex Inst, Van Nuys, CA 91406
14196	Electr Controls, Wilton, CT 06897
14198	American Labs, Fullerton, CA 92634
14332	Pelton, Arcadia, CA 91006
14433	ITT, W Palm Beach, FL 33402
14482	Welkins & Johnson, Palo Alto, CA 94304
14608	Corbin, Berlin, CT 06037
14655	Cornell Dubilier, Newark, NJ 07101
14674	Corning Glass, Corning, NY 14830
14749	Accopan, Easton, PA 18042
14752	Electrocube, San Gabriel, CA 91776
14889	R&G Sloan, Sun Valley, CA 91352
14908	Electr Inst & Socity, Stoneham, MA 02180
14936	General Inst, Hicksville, NY 11802
15238	ITT, Lawrence, MA 08142
15476	Digital Equip, Maynard, MA 01754
15605	Cutler Hammer, Milwaukee, WI 53202
15782	Houston Inst, Bellaire, TX 77401
15801	Fenwal Electrs, Framingham, MA 01701
15819	Precision Rush, St Louis, MO 63111
16037	Spruce Pine Mica, Spruce Pine, NC 28777
16088	Inmtrl Diode, Jersey City, NJ 07304
16179	Omni Spectra, Farmington, MI 48024
16301	Astrolab, Linden, NJ 07036
16352	Cadi, Fairlawn, NJ 07410
16485	Sterling Inst, New Hyde Park, NY 11040
16636	Indiana General, Oglesby, IL 61348
16758	Delco, Kokomo, IN 46901
16950	Precision Dynamics, Burbank, CA 91504
16995	Amer Micro Devices, Summerville, SC 29483
17117	Electr Molding, Woonsocket, RI 02895
17540	Mohawk Spring, Schenectady Park, IL 80176
17545	Transducer Prcsn, Hagerstown MD 21740
17711	Singer, Somerville, NJ 08876
17850	Zetex, Concord CA 94520
17856	Siliconix, Santa Clara, CA 95054
18324	Signetics, Sunnyvale, CA 94086
18564	New Prod Eng, Plymouth IN 46992
18677	Scanbe, El Monte, CA 91731
18736	Computer Diode, S Paterson, NJ 07936
18796	Vicon, Sunnyvale, CA 94086
18911	Durant Watertown, WI 53094
19178	Zero, Monson, MA 01057
19209	GE, Burlington, IA 52601
19373	Easton Electrs, Milford, MA 01830
19396	Pakiron, Vienna, VA 22180
19611	Pan West Eng, Pittsburgh, PA 15237
19644	LRC Electrs, Horsehead, NY 14845
19701	Electra Independence, KS 67301
20093	Vitramon, Bridgeport, CT 06601
20754	KMC, Long Valley, NJ 07853
21335	Fafnir Bearing, New Britian, CT 06050
21688	Raytheon, Norwood, MA 02062
21759	Lamar Fuglo, Jr Plainfield, NJ 07060
22526	Berg Electrs, New Cumberland, PA 17070
22589	Electro Space Fabrctrs, Topton, PA 19562
22753	Uitrex, Palo Alto, Norwood, FL 33022
23338	Wavelab, San Diego, CA 92112
23342	Avnet Electrs, Franklin Park, IL 60131
23936	Perkinson, Burlingame, CA 94010
24355	Indiana Gnrl Electrc, Keasby, NJ 08832
24355	Analog Devices, Cambridge, MA 02142
24446	General Semicond, Tempe, AZ 85281
24446	GE, Schenectady, NY 12305
24454	GE, Syracuse, NY 13201
24455	GE, Cleveland, OH 44112
24602	EMC Technlgy, Cherry Hill, NJ 08034
24655	Gen Prod, Concord, MA 01742
24759	Lamar Fugle, S Plainfield, NJ 07080
25008	Vactrix, Berkeley, CA 94710
25289	EG&G, Bedford, MA 01730
25801	Tri-County Tube, Nashua, NY 14517
26805	Omni Spectra, Waltham, MA 02154
26806	American Zettler, Costa Mesa, CA 92626
27014	National Semi, Santa Clara, CA 95051
27545	Hartford Universal Bell, Rocky Hill, CT 06067
28480	HP, Palo Alto, CA 94304
28520	Heyman Mfg, Kenilworth, NJ 07033
28875	IMC Magnetics, Rochester NH 03867
29959	Hoffman Electrs, El Monte, CA 91734
30043	Solid State Devices, La Mirada, CA 90638
30646	Beckman Inst, Cedar Grove, NJ 07009
30874	IBM, Armonk, NY 10504
30985	Inland, Santa Clara, CA 95051
31019	Solid State Scntfc, Monigomerville, PA 18936
31514	Standford Appld Eng, Costa Mesa, CA 92626
31814	Analogic, Peabody, MA 01880
31951	Trimdge, Pittsburgh, PA 15231
32001	Jenson, Chicago, IL 60638
32396	Spectrum Control, Fairview, PA 16415
33173	GE, Owensboro, KY 42301
34141	Koehler, Marlboro, MA 01752
34156	Semicon, Costa Mesa, CA 92626
34333	Silicon Genrl, Westminster, CA 92683
34335	Advanced Micro Devices, Sunnyvale, CA 94086
34649	Intel, Santa Clara, CA 95051
34677	Solitron Devices, Jupiter, FL 33458
35929	Constantx, Montreal, QUE, CAN
36462	National Ltd, Montreal, QUE, CAN
37942	Mallory, Indianapolis, IN 46206
38443	Marlin Rockwell, Jamestown, NY 14701
39317	Mc Gill Mfg, Valparaiso, IN 46383
40931	Honeywell, Minneapolis, MN 55408
42190	Muter, Chicago, IL 60638
42498	National Metronic, MA 02178
43334	New Departurs-Hyatt, Sandusky, OH 44870
43991	Norma Hoffman, Stanford, CT 06904
49671	RCA, New York, NY 10020
49956	Raytheon, Waltham, MA 02154
50088	Mostek, Carrollton, TX 75006
50101	GHZ Devices, S Chelmsford, MA 01824
50507	Micro Networks, Worcester, MA 01606
50522	Monsanto, Palo Alto, CA 94304
50721	Datel Systems, Canton, MA 02021
51167	Aries Electrs, Frenchtown, NJ 08825
51553	Diablo Systems, Hayward, CA 94545
51642	Centre Eng, State College, PA 16801
52648	Plessey Sania, Ana CA 92705
52676	SKF Inds, Philadelphia, PA 19132
52763	Stettner Trush, Cazenovia, NY 13035
53021	Sanganio Electr, Springfield, IL 62705
53184	Xciton, Latham, NY 12110
53421	Tyrion, Milwaukee, WI 53209
54294	Shallcross, Selma, NC 27576
54297	Assoc Prec Prod, Huntsville, AL 35805
54715	Shure Bros, Evanston, IL 60202
56289	Sprague, North Adams, MA 01247
57711	Stimpson, Bayport, NY 11705
58563	Superior Valve, Washington, PA 15301
58730	Thomas & Betts, Elizabeth, NJ 07207
59875	TRW Cleveland, OH 44117
60399	Torrington, Torrington, CT 06790
61007	Townsend, Braintree, MA 02184
61637	Union Carbide, New York, NY 10017
61984	United Carr Fast, Boston, MA
63060	Victoreen, Cleveland, OH 44104
63743	Ward Leonard, Mt Vernon, NY 10550
65083	Westinghouse, Bloomfield, NJ 07003
65092	Weston, Newton Falls, OH 06403
70108	Acushnet Cap, New Bedford, MA 02742
70109	Adams & Westlake, Elkhart, IN 46514
70417	Chrysler, Detroit MI 48231
70485	Atlantic Inds Rubber, Chicago IL 60607
70563	Amperite Union City, NJ 07087
70611	Ark Les Switch, Watertown, MA 02172
70892	Beed Chain, Bridgeport CT 06605
70903	Belden, Chicago IL 60544
71126	Bonnon, Beacon Falls, CT 06403
71279	Cambridge Thermionic, Cambridge MA 02138
71294	Canfield, Clifton Forge, VA 24422
71400	Bussmann, St Louis, MO 63107
71450	CTS, Elkhart IN 46514
71468	Cannon, Los Angeles CA 90031
71482	Claro, Chicago, IL 60645
71590	Centralab, Milwaukee, WI 53212
71686	Continental Carbon, New York, NY
71707	Coto Coil, Providence RI 02905
71729	Crescent Rbr, Philadelphia, PA 19134
71744	Chicago Min Lamp, Chicago IL 60640
71785	Cinch, Chicago IL 60624
71823	Darnell Downey, CA 90241
72136	Electromotive Willamantic CT 06226
72228	Continental Screw, New Bedford, MA 02742
72259	Raytheon, Quincy, MA 02169
72619	Dialight, Brooklyn, NY 11237
72699	General Inst, Newark, NJ 07104
72765	Drake, Chicago, IL 60631
72794	Dzus Fastener, W Islip, NY 11795
72825	Eby, Philadelphia PA 19144
72962	Elastic Stop Nut, Union, NJ 07083
72982	Erie, Erie, PA 16512
73445	Amperex Electrs, Hicksville, NY 11801
73559	Carling Electr, Hartford, CT 06110
73690	Elco Resistor, New York, NY
73803	TI, Attleboro, MA 02703
73899	JFD Electrs, Brooklyn, NY 11210
73967	Groov Pin, Ridgefield, NJ 07657
74193	Hennemann, Trenton, NJ 08602
74199	Quam Nichols, Chicago IL 60637
74445	Holo Krome, Hartford, CT 06110
74545	Hubbell, Strafford, CT 06497
74861	Industrial Cndnsr, Chicago, IL 60618
74868	Amphenol, Danbury, CT 06810
74970	Johnson, Wessex, MN 56093
75042	IRC(TRW), Burlington IA 52601
75376	Kurz Kasch, Dayton OH 45401
75382	Kulka Mt Vernon, NY 10551
75491	Lafayette, Scrsdale NY 11791
75608	Linden, Providence RI 02905
75915	Littelfuse, Des Plains, IL 60016
76005	Lord Mfg, Erie PA 16512
76149	Mallory Electr, Detroit MI 48204
76241	Maurey, Chicago IL 60616
76381	3 M Co, St Paul, MN 55101
76385	Minor Rubber, Bloomfield, NJ 07003
76487	Millen, Malden MA 02148
76545	Muller Electrs, Cleveland, OH 44114
76684	National Tube, Pittsburg PA
76854	Oak Inds, Crystal Lake, IL 60014
77132	Dot Fastener, Hartford, CT 06120
77147	Patton MacGuyer, Providence, RI 02905
77166	Pass Seymour, Syracuse, NY 13209
77263	Pierce Roberts Rubber, Trenton, NJ 08638
77315	Platt Bros, Waterbury, CT 06720
77339	Positive Lockwasher, Newark, NJ
77342	AMP, Princeton, IN 47570
77542	Ray-o-Vac, Madison, WI 53703
77630	TRW, Camden, NJ 08103
77638	General Inst, Bridgeport, NY 11211
78189	Shakeproof, Elgin, IL 60120
78277	Sigma Inst, Braintree MA 02184
78479	Avnet Elcto Sply, Phx, AZ 85067
78488	Stackpole, St Marys, PA 15867
78553	Tinnerman, Cleveland, OH
78711	Telephonics, Huntington, NY 11743
79089	RCA, Harrison, NJ 07029
79136	Waldes Kohinoor, New York, NY 11101
79497	Western Rubber, Goshen, IN 46526
79725	Wiremold, Hartford, CT 06110
79727	Continental Wirt, Philadelphia, PA 19101
79840	Mallory Control, Frankfort, IN 46041
79963	Zierick, Mt Kisco, NY 10549
80009	Tektronix, Beaverton, OR 97005
80030	Prestole Fastener, Toledo, OH 43605
80048	Vickers, St Louis MO 63166
80103	Lambda, Melville, NY 11746
80183	Sprague, N Adams, MA 01247
80211	Motorola, Franklin Pk, IL 60131
80251	Formica, Cincinnati, OH 45232
80258	Standard Oil, Lafayette, IN 47902
80294	Bourns Labs, Riverside, CA 92506
80368	Sylvania, New York, NY 10017
80431	Arr Filter, Milwaukee, WI 53218
80583	Hammarlund, New York, NY 10010
80740	Beckman Inst, Fullerton, CA 92634
80756	TRW Ramsey, St Louis, MO 63166
80894	Pure Carbon, St Marys, PA 15857
81030	Int'l Inst, Orange, CT 06477
81073	Grayhill, LaGrange IL 60525
81143	Industria, Stirling, NJ 07980
81312	Winchester, Oakville, CT 06779
81349	Military Specifications
81350	Joint Army-Navy Specifications
81483	Int'l Rectifier, El Segundo, CA 90245
81741	Chicago Lock, Chicago, IL 60641
81831	Fittco, Flushing, NY 11354
81840	Ladex, Dayton, OH 45402
81860	Barry Wright, Watertown, MA 02172
82219	Sylvania, Emporium, PA 15834
82227	No. Amer Philips, Cheshire, CT 06410
82273	IN Pattern & Model, LaPort, IN 46350
82389	Switchcraft, Chicago, IL 60630
82561	Reeves Hoffman, Carlisle, PA 17013
82647	Metals & Controls, Attleboro, MA 02703
82697	Milwaukee Resistor, Milwaukee, WI 53204
82877	Rotron, Woodstock, NY 12498
82901	IN General Magnet, Valparaiso, IN 46383
83003	Vaco Garland, TX 75040
83014	Hartwell, Placentia, CA 92670
83033	Messner, Mt Carmel, IL 62863
83058	Carr Fastener, Cambridge, MA 02142
83070	Victory Eng, Springfield, NJ 07081
83259	Parker Seal, Culver City, CA 90231
83330	H H Smith, Brooklyn, NY 11207
83421	Bearing Spcity, Bal Pinnacle, CA
83587	Solar Electr, Warren, PA 16365
83594	Burroughs, Plainfield, NJ 07061
83740	Union Carbide, New York, NY 10017
83768	Mass Engrg, Quincy, MA 02171
83781	National Electrs, Geneva, IL 60134
84411	TRW, Capistrano, CA 92624
84825	Lehigh Metals, Cambridge, MA 02140
84970	Series Tarrian, Bloomington, IN 47401
84971	TA Mfg, Los Angeles, CA 90039
86604	Kepco, Flushing, NY 11352
86620	Pyson Casters, Gurnee, IL 60031
86684	RCA, Harrison, NJ 07029
86684	REC, New Rochelle, NY 10801
86800	Cent Electrs, Brooklyn, NY 11222
88140	Cutler Hammer, Lincoln, IL 62656
88204	GTE Sylvania, Ipswich, MA 01938
88219	Gould Nat Battery, Trenton, NJ 08697
88419	Cornell Dubilier, Fuquay Varina, NC 27526
88827	K&G Mfr, New York, NY
89265	Porter & Brumfield, Princeton, IN 47671
89482	Holtzer Cabot, Boston, MA 02119
89665	United Transformer, Chicago, IL
89870	Berkshire Transformer, Kent, CT 06757
90201	Mallory Cap, Indianapolis, IN 46206
90303	Mallory Sat, Tarrytown, NY 10591
90634	Gulton Inds, Metuchen, NJ 08840
90750	Wstnghouse Boston, MA 02118
90952	Hardwere Prod, Reading, PA 19607
91002	Continental Wire, York, PA 17405
91146	Cannon, Salem, MA 01970
91210	Gerber, Mishawaka, IN 46544
91293	Johanson, Boonton, NJ 07005
91417	Harris, Melbourne, FL 32901
91506	Auger Bros, Attleboro, MA 02703
91598	Chandler, Westerville, OH 43081
91637	Dale Electrs, Columbus, NE 68601
91662	Elco, Willow Grove, PA 19090
91737	General Inst, Dallas, TX 75222
91836	Kings Electrs, Tuckahoe, NY 11723
91916	Mephisto Tool, Hudson, NY 12534
91929	Honeywell, Freeport, IL 61032
92519	Electra Insul, Woodside, NY 11377
92628	Edgerton Germeshausen, Boston, MA 02118
92702	IMC Magnetics, Westbury, NY 11590
92739	Ampex, Redwood City, CA 94063
92966	Hudson Lamp, Kearny, NJ 07032
93332	Sylvania, Woburn, MA
93346	Amer Electrs Labs, Lansdale, PA 19446
93618	R&C Mfg, Ramsey, PA 16671
93816	Cramer, New York, NY 10013
94144	Raytheon, Quincy, MA 02169
94154	Wagner Electr, Lindenhurst, IL 07039
94271	Wenton, Arlington, PA 19403
94322	Tel Labs, Manchester, NH 03102
94589	Dickson, Chicago, IL 60619
94696	Magnetech Electrs, Chicago, IL 60630
94800	Atlas Ind, Brookline, NH 03033
95076	Gerde, Cumberland, RI 02864
95121	Quality Comp, St Marys, PA 15857
95146	Alco Electrs, Lawrence, MA 01843
95238	Continental Conn, Woodside, NY 11377
95276	Vitramon, Bridgeport, CT 06601
95348	Gordos, Bloomfield, NJ 07003
95354	Methode, Rolling Meadow, IL 60008
95794	Amer Brass, Torrington, CT 06790
95987	Weckesser, Chicago, IL 60646
96095	Aerovox Hi Q, Olsen, NY 14760
96341	Microwave Assoc, Burlington, MA 01801
96906	Military Standards
97918	Linemaster Switch, Woodstock, CT 06281
98291	Sealectro, Mamaroneck, NY 10544
98474	Comper, Burlingame, CA 94010
98821	North Hills, Glen Cove, NY 11542
99017	Protective Closures, Buffalo, NY 14207
99117	Metavac, Flushing, NY 11368
99313	Varian Palo Alto, CA 94303
99378	Atlas, Winchester, MA 01890
99800	Delevan, E Aurora, NY 14052
99934	Renbrandt, Boston, MA 02118
99942	Centralab, Milwaukee, WI 53201

ELECTRICAL PARTS LIST

CHASSIS MOUNTED PARTS

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 106	CAP CER DISC 2200PF 10PCT 500V	4406-2228	72982	8710822Z5D00222J
C 501	CAP CER DISC 3300PF 10PCT 500V	4406-2339	72982	0801082Z5U00332Z
C 502	CAP CER DISC 3300PF 10PCT 500V	4406-2339	72982	0801082Z5U00332Z
F 501	FUSE SLO-BLOW 3/10A 250V	5330-0800	75915	313 .300
F 502	FUSE SLO-BLOW 3/10A 250V	5330-0800	75915	313 .300
J 101	BINDING POST ASM	0938-3000	24655	0938-3000
J 102	BINDING POST ASM	0938-3000	24655	0938-3000
J 103	BINDING POST ASM	0938-3022	24655	0938-3022
J 104	PHONE GND .281L 2 CKT	4260-1030	82389	111
P 501	LAMP BAYONET BASE 6.3V	5600-0700	71744	44
PL 501	RECEPTACLE POWER IEC STD 6A 250V	4240-0210	24655	4240-0210
Q 104	TRANSISTOR 2N176	8210-1760	04713	2N176
Q 106	TRANSISTOR 2N176	8210-1760	04713	2N176
Q 501	TRANSISTOR 2N1540	8210-1540	04713	2N1540
R 101	RES FLM 32K 1/2 PCT 1/4W	6351-2320	81349	RN60D3202D
R 102	RES FLM 32K 1/2 PCT 1/4W	6351-2320	81349	RN60D3202D
R 103	RES FLM 26.7K 1/2 PCT 1/4W	6351-2267	81349	RN60D2672D
R 104	RES FLM 26.7K 1/2 PCT 1/4W	6351-2267	81349	RN60D2672D
R 105	RES FLM 16K 1/2 PCT 1/4W	6351-2160	81349	RN60D1602D
R 106	RES FLM 16K 1/2 PCT 1/4W	6351-2160	81349	RN60D1602D
R 107	RES FLM 13.3K 1/2 PCT 1/4W	6351-2133	81349	RN60D1332D
R 108	RES FLM 13.3K 1/2 PCT 1/4W	6351-2133	81349	RN60D1332D
R 109	RES FLM 8K 1/2 PCT 1/4W	6351-1800	81349	RN60D8001D
R 110	RES FLM 8K 1/2 PCT 1/4W	6351-1800	81349	RN60D8001D
R 111	RES FLM 4K 1/2 PCT 1/4W	6351-1400	81349	RN60D4001D
R 112	RES FLM 4K 1/2 PCT 1/4W	6351-1400	81349	RN60D4001D
R 113	RES FLM 3.2K 1/2 PCT 1/4W	6351-1320	81349	RN60D3201D
R 114	RES FLM 3.2K 1/2 PCT 1/4W	6351-1320	81349	RN60D3201D
R 115	RES FLM 1.6K 1/2 PCT 1/4W	6351-1160	81349	RN60D1601D
R 116	RES FLM 1.6K 1/2 PCT 1/4W	6351-1160	81349	RN60D1601D
R 117	RES FLM 800 OHM 1/2 PCT 1/4W	6351-0800	81349	RN60D8000D
R 118	RES FLM 800 OHM 1/2 PCT 1/4W	6351-0800	81349	RN60D8000D
R 119	RES FLM 320 OHM 1/2 PCT 1/4W	6351-0320	81349	RN60D3200D
R 120	RES FLM 320 OHM 1/2 PCT 1/4W	6351-0320	81349	RN60D3200D
R 121	RES FLM 160 OHM 1/2 PCT 1/4W	6351-0160	81349	RN60D1600D
R 122	RES FLM 160 OHM 1/2 PCT 1/4W	6351-0160	81349	RN60D1600D
R 138	POT COMP KNOB 250 OHM 10 PCT LIN	6000-0108	01121	JAIN056S251UZ
R 139	POTENTIOMETER	0971-3905	24655	0971-3905
R 141	RES COMP 150 OHM 5PCT 1/2W	6100-1155	81349	RCR20G151J
R 504	RES COMP 2.2 K 5PCT 1/2W	6100-2225	81349	RCR20G222J
R 505	RES WW MOLDED .47 OHM 10 PCT 2W	6760-8479	75042	BWH 0.47 OHM 10PCT
R 506	RES WW MOLDED .47 OHM 10 PCT 2W	6760-8479	75042	BWH 0.47 OHM 10PCT
S 101	SWITCH ROTARY ASM	7890-3100	24655	7890-3100
S 102	SWITCH ROTARY ASM	7890-3110	24655	7890-3110
S 501	SWITCH TOGGLE 2POS DPST STEADY	7910-1300	04009	83053
T 101	TRANSFORMER OUTPUT	0745-4250	24655	0745-4250
T 501	TRANSFORMER POWER	0745-4240	24655	0745-4240

ELECTRICAL PARTS LIST

PC BOARD ASM P/N 1311-2791

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 101	CAP MYLAR .1UF 1 PCT 100V	4860-8249	56289	410P 0.1 UF 1PCT
C 102	CAP ALUM 100 UF 15V	4450-2800	56289	30D107G015
C 103	CAP MYLAR .1UF 1 PCT 100V	4860-8249	56289	410P 0.1 UF 1PCT
C 104	CAP CER DISC 1500PF 10PCT 500V	4406-2158	72982	081108Z5F00152K
C 105	CAP ALUM 1500-750-750 UF 25V	4450-0700	56289	60D 25V
C 107	CAP CER DISC 680PF 5PCT 500V	4404-1685	72982	083108Z5D00680J
C 108	CAP MYLAR .033UF 10 PCT 100V	4860-7865	56289	410P .033 UF 10PCT
C 109	CAP ALUM 100 UF 15V	4450-2800	56289	30D107G015
C 110	CAP ALUM 100 UF 15V	4450-2800	56289	30D107G015
C 111	CAP MICA 3300PF 10PCT 500V	4570-1333	72136	DM20FD332K03CR
C 112	CAP ALUM 5 UF 50V	4450-3900	56289	30D505G050
C 113	CAP CER DISC 1000PF 80/20PCT 500	4404-2109	72982	083108Z5U001022
C 503	CAP ALUM 450-225-225 UF 100V	4450-4000	56289	60D 100V
CR 501	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 502	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 503	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 504	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 505	ZENER 1N969B 22V 5PCT .4W	6083-1058	14433	1N969B
Q 101	TRANSISTOR 2N1304	8210-1304	01295	2N1304
Q 102	TRANSISTOR 2N1305	8210-1305	01295	2N1305
Q 103	TRANSISTOR 2N1304	8210-1304	01295	2N1304
Q 105	TRANSISTOR 2N1305	8210-1305	01295	2N1305
Q 502	TRANSISTOR 2N3903	8210-1132	04713	2N3903
R 123	RES COMP 11 K OHM 5PCT 1/2W	6100-3115	81349	RCR20G113J
R 124	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 125	RES COMP 33 K 5PCT 1/2W	6100-3335	81349	RCR20G333J
R 126	RES COMP 220 OHM 5PCT 1/2W	6100-1225	81349	RCR20G221J
R 127	RES COMP 150 OHM 5PCT 1/2W	6100-1155	81349	RCR20G151J
R 128	THERMISTOR 30K OHM 25PCT	6740-1402	15801	GB-43V1
R 129	POT COMP TRM 250 OHM 20PCT 1T	6040-0200	01121	YR251M
R 130	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 131	RES COMP 6.8 K 5PCT 1/2W	6100-2685	81349	RCR20G682J
R 132	RES COMP 10 OHM 5PCT 1/2W	6100-0105	81349	RCR20G100J
R 133	RES COMP 680 OHM 5PCT 1/2W	6100-1685	81349	RCR20G681J
R 134	RES COMP 24 OHM 5PCT 1/2W	6100-0245	81349	RCR20G240J
R 135	RES COMP 1.0 K 5PCT 1/2W	6100-2105	81349	RCR20G102J
R 136	RES COMP 2.2 K 5PCT 1/2W	6100-2225	81349	RCR20G222J
R 137	RES COMP 24 OHM 5PCT 1/2W	6100-0245	81349	RCR20G240J
R 140	RES COMP 4.7 K 5PCT 1/2W	6100-2475	81349	RCR20G472J
R 502	RES COMP 47 OHM 5PCT 1/2W	6100-0475	81349	RCR20G470J
R 503	RES COMP 2.2 K 5PCT 1/2W	6100-2225	81349	RCR20G222J

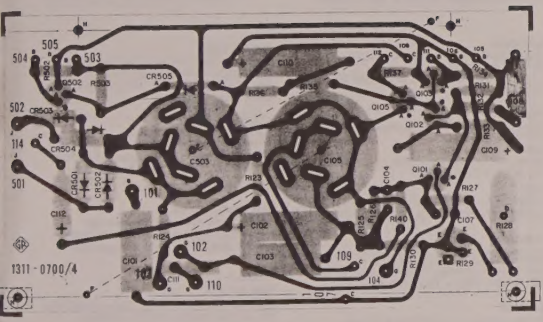


Figure 5-5. Etched circuit board (P/N 1311-2701).

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.

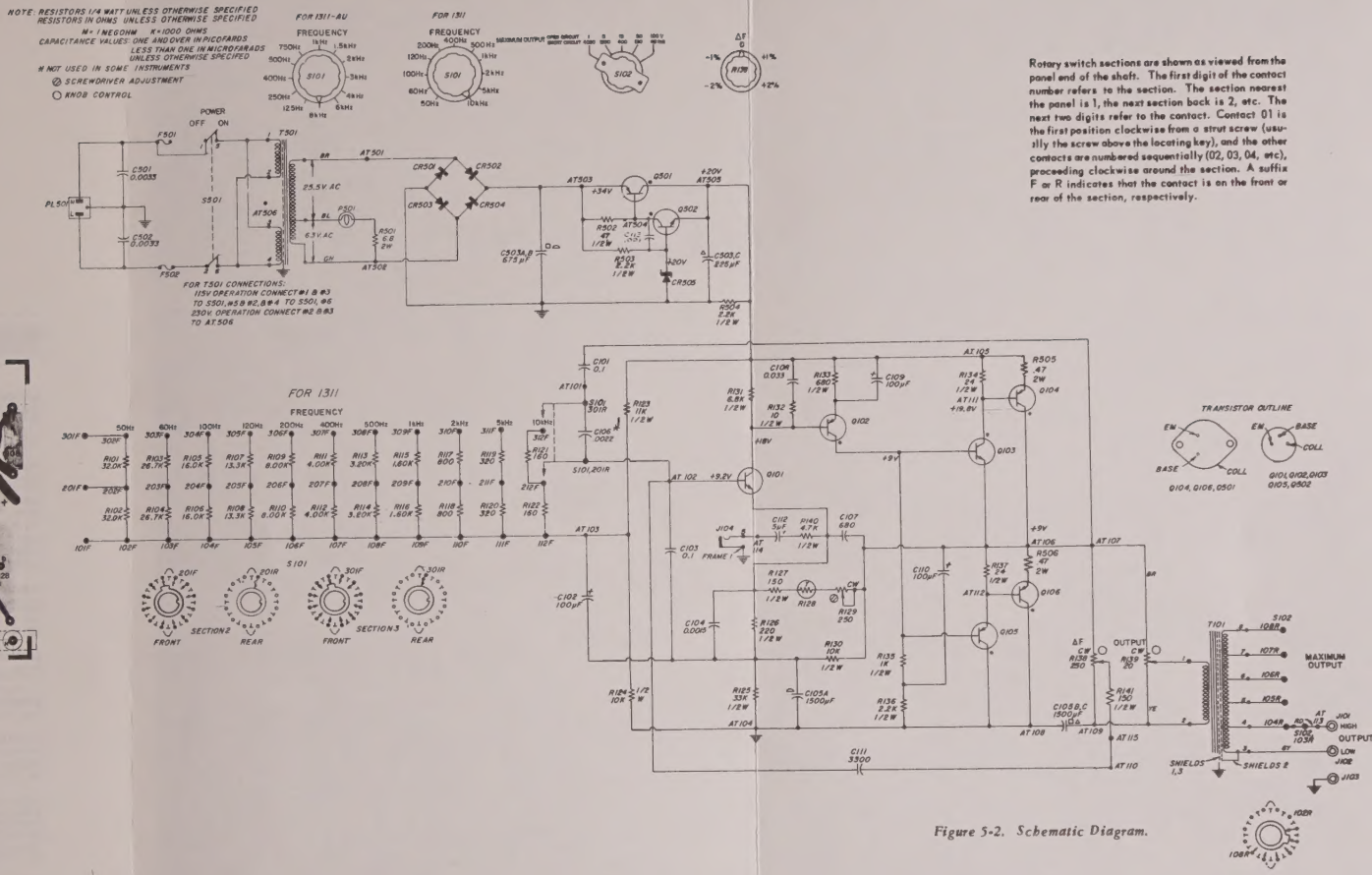


Figure 5-2. Schematic Diagram.

Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

300 Baker Avenue
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Tel: 416/252-3395 • TELEX: 06-96724
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EUROPE, AFRICA, and NEAR EAST
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P.O. Box CH-8034, Zürich, Switzerland
Tel: (01) 55 24 20 • TELEX: 854-53638
***Paris** (01) 797 07 39
***Milano** (02) 20 92 57
***München** (089) 40 18 01
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***ASIA, PACIFIC, and LATIN AMERICA**
GenRad, Marketing & International Division
300 Baker Avenue, Concord, MA 01742
TWX: 710 347-1051 • TELEX: 92-3354
Cable: GENRADCO CONCORD (Mass)

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300 Baker Avenue, Concord, MA 01742